Plant Assessment Form

For use with the "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands" by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association (Warner et al. 2003)

Printable version, February 28, 2003
(Modified for use in Arizona, 07/02/04)

Table 1. Species and Evaluator Information

Species name (Latin binomial)**:**	*Tamarix chinensis* Lour.; *Tamarix parviflora* DC.; *Tamarix ramosissima* Ledeb. (USDA 2005)
Synonyms:	*Tamarix chinensis* Lour.: None listed in USDA (2005); *Tamarix parviflora* DC.: *Tamarix tetrandra* auct. non Pallas (USDA 2005); *Tamarix ramosissima* Ledeb.: None listed in USDA (2005)
Common names:	*Tamarix chinensis* Lour.: Fivestamen tamarisk, tamarisk, saltcedar; *Tamarix parviflora* DC.: Smallflower tamarisk, tamarisk, saltcedar; *Tamarix ramosissima* Ledeb.: saltcedar, tamarisk
Evaluation date (mm/dd/yy)**:**	04/22/04
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Committee review date:	08/06/04
List date:	08/06/04
Re-evaluation date(s):	

Taxonomic Comment

Some taxonomic confusion exits for *Tamarix* spp. in the U.S., as several species were introduced. T*amarix ramosissima* and *T. chinensis* are allopatric in Asia; however, in the U.S. they are synpatric and their hybrid, which has not been found in Asia, is common. *Tamarix parviflora*, although recognized as a separate species, readily hybridizes with *T. ramosissima* and other closely related *Tamarix* spp. The significant amount of hybridization makes these species difficult to tell apart in the U.S. For the purposes of this assessment, all three species are evaluated here collectively with an emphasis on *T. ramosissima*, as the most common species. *Tamarix aphylla* is treated in a separate assessment. Preceding information is based on a personal communication with J. Gaskin (North America Flora author, *Tamarix*, 2004).

Table 2. Scores, Designations, and Documentation Levels

<table>
<tr><th colspan="2">Question</th><th>Score</th><th>Documentation Level</th><th>Section Scores</th><th>Overall Score & Designations</th></tr>
<tr><td>1.1</td><td>Impact on abiotic ecosystem processes</td><td>A</td><td>Reviewed scientific publication</td><td rowspan="4">“Impact”

Section 1 Score:

A</td><td rowspan="12">“Plant Score”

Overall Score:

High

Alert Status:

None</td></tr>
<tr><td>1.2</td><td>Impact on plant community</td><td>A</td><td>Reviewed scientific publication</td></tr>
<tr><td>1.3</td><td>Impact on higher trophic levels</td><td>A</td><td>Reviewed scientific publication</td></tr>
<tr><td>1.4</td><td>Impact on genetic integrity</td><td>D</td><td>Other published material</td></tr>
<tr><td colspan="4"></td><td></td></tr>
<tr><td>2.1</td><td>Role of anthropogenic and natural disturbance</td><td>A</td><td>Reviewed scientific publication</td><td rowspan="7">“Invasiveness”

For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:

19 pts

Section 2 Score:

A</td></tr>
<tr><td>2.2</td><td>Local rate of spread with no management</td><td>A</td><td>Observational</td></tr>
<tr><td>2.3</td><td>Recent trend in total area infested within state</td><td>B</td><td>Other published material</td></tr>
<tr><td>2.4</td><td>Innate reproductive potential</td><td>A</td><td>Reviewed scientific publication</td></tr>
<tr><td>2.5</td><td>Potential for human-caused dispersal</td><td>A</td><td>Reviewed scientific publication</td></tr>
<tr><td>2.6</td><td>Potential for natural long-distance dispersal</td><td>A</td><td>Other published material</td></tr>
<tr><td>2.7</td><td>Other regions invaded</td><td>B</td><td>Other published material</td><td rowspan="4">RED FLAG
YES

Something you should know.</td></tr>
<tr><td colspan="4"></td><td></td></tr>
<tr><td>3.1</td><td>Ecological amplitude</td><td>A</td><td>Other published material</td><td rowspan="2">“Distribution”

Section 3 Score:

A</td></tr>
<tr><td>3.2</td><td>Distribution</td><td>A</td><td>Observational</td></tr>
</table>

Red Flag Annotation

The ecological impacts associated with invasion by *Tamarix* spp. should be considered within the context of the specific riparian community invaded. In addition, such impacts may be mediated by previous changes to a variety of ecological processes associated with the particular riparian community. Land managers planning riparian restoration projects involving the control of *Tamarix* spp. should consider and address, as appropriate, other factors, such as existing hydrologic regimes, fluvial processes, and whether

Tamarix spp. stands are providing habitat for southwestern willow flycatchers (*Empidonax traillii extimus*), before proceeding with such projects.

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify ecosystem processes impacted: Tamarisk dominance in riparian areas changes hydrology by increasing overbank flooding and alters geomorphologic process. With the dominance of tamarisk, riparian areas have seen increases in fire frequency. Tamarisk's deep root and lateral branching enables it to draw down the water table and dense populations increase the salinity of the soil surface.
Rationale: Many reviews indicate that tamarisk reduces the width, depth, and water-holding capacity of river channels by trapping and stabilizing alluvial sediments, and thus increases the frequency and severity of overbank flooding (Dudley et al. 2000, Lovich 2000). Studies along the Green and Yampa rivers by Cooper et al. (2003) suggests that tamarisk stems change the landscape properties of gravel and cobble islands and bars, as well as those of adjacent channels. Near-bed flow velocities decreased and the sheer stress required to remobilize the channel bed increased. The dense woody roots of tamarisk increased the gravel bar's resistance to mobilization (Cooper et al. 2003). Fire appears to be less common in riparian ecosystems where tamarisk has not invaded. On dammed rivers, the structure of tamarisk stands may be more favorable to carry fire. Increases in fire size and frequency in riparian areas are attributed to a number of factors including an increase in ignition sources, increased fire frequency in surrounding uplands, and increased abundance of fuels (Busch and Smith 1993). Drier floodplain environments are the result of altered disturbance regimes such as dams and diversions, groundwater pumping, agriculture, and urban development, which have contributed to lower base flows, reduced water tables and changes in the frequency, timing and severity of flooding (Zouhar 2003). Tamarisk is a facultative phreatophyte and halophyte with a deep, extensive root system that extends to the water table, and is also capable of extracting water from unsaturated soil layers. Its primary root grows with little branching until it reaches the water table, at which point secondary root branching is profuse (Brotherson and Winkel 1986). Tamarisk evapotranspiration rates are among the highest levels of any phreatophyte evaluated in southwestern North America, including other native riparian trees. Several reviews and studies suggest that tamarisk has high transpiration rates and that tamarisk stands use more water than native vegetation, thus drawing down water tables, desiccating floodplains, and lowering flow rates of waterways (Brotherson and Field 1987). It is reported that tamarisk contains 41,000 ppm dissolved solids in its guttation sap (DiTomaso 1998). Tamarisk accumulates salt in special glands in its leaves, and then excretes it onto the leaf surface. These salts accumulate in the surface layer of soil when plants drop their leaves (Mozingo 1987). Brotherson and Field (1987) concluded that tamarisk deposited NaCl beneath its canopy as an allelochemical agent. Along regulated rivers that no longer experience annual flooding and scouring, surface soils become more saline over time (Busch and Smith 1993).
Sources of information: See cited literature.

Question 1.2 Impact on plant community composition**,** structure, and interactions *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify type of impact or alteration: In altered riparian systems, tamarisk forms dense monotypic stands that compete with and replace native vegetation such as cottonwood and willow species. Despite similar competitive abilities, tamarisk is more tolerant of ground water declines than native species,

which may facilitate its establishment over native species. Tamarisk disrupts natural succession in native plant communities. It reduces seedling recruitment of other species through deposition of salts on the soil surface and creation of a new structural layer of litter. Native species are not adapted to increased fire frequency in tamarisk-dominated areas.

Rationale: Tamarisk communities are commonly associated with disruptions in historic disturbance regimes. Damming and subsequent management on most western rivers for water and electric power have resulted in increased evaporation and associated salinity, changes in erosion and sedimentation rates, and other physicochemical changes (Zouhar 2003).

Tamarisk dominated communities are often monotypic, though arrowweed and screwbean mesquite (*P. pubescens*) are common associates, and big saltbrush (*Atriplex lentiformis*) may occur in saline areas (Hasse 1972). Anderson et al 1977 described salt cedar communities along the lower Colorado River with salt cedar constituting 95 to 100% of the total trees. Cottonwood communities along the Colorado River, for example, have decreased from over 5,000 acres (2,000 ha) in the 1600s to less than 500 acres (200 ha) in 1998 (Briggs and Cornelius 1998). Tamarisk has since replaced up to 90% of the riparian communities historically dominated by cottonwood-willow forests. Tamarisk has almost completely replaced the native forest that historically dominated the riparian corridor from the Grand Canyon to the delta on the Gulf of California. It is by far the most abundant plant in the Colorado River delta, accounting for 40% of total ground cover (Westbrooks 1998).

In disturbed riparian environments where salinities are elevated or water tables depressed, tamarisk's deep root system gives it a competitive advantage over native, obligate phreatophytes (e.g. cottonwood and willow). Studies demonstrate that tamarisk is more tolerant of ground water declines that the native Goodings willow (*Salix goodingii*). Tamarisk is a facultative phreatophyte, with the ability to draw from the alluvial water table, but is also capable of surviving by extracting water, thus surviving indefinitely on unsaturated soils. In contrast, Goodings willow is an obligate phreatophyte, relying solely on the groundwater (Turner 1974, Stromberg 1997). Tamarisk seedlings are better able to survive water stress (i.e., low flows) and are more likely to survive until water becomes available, in contrast to *Salix* seedlings. This is one way that tamarisk is able to out-compete native vegetation and successfully invade disturbed riparian habitats (Horton and Clark 2001).

Tamarisk is less sensitive to changes in ground water availability than native riparian trees with which it is commonly associated. Greater tolerance of water stress can lead to tamarisk dominance on relatively dry riparian sites (Zouhar 2003). The longer a community has been invaded by tamarisk, the more xeric in nature are the plant species that occupy the understory. Deposits of salt-encrusted needle-like leaves are at times more than 1 m deep and can inhibit the germination of other species (Di Tomaso 1998). Research by Stromberg (1998) suggests that the functional role of tamarisk is context-specific and variable among rivers. In a study on a free-flowing river, understory herbaceous cover and species richness (including exotics) were significantly greater than in cottonwood stands, perhaps due to soil differences that developed between the two stand types (e.g., higher clay content in salt cedar soils). Stem densities of velvet mesquite (*Prosopis velutina*) and other woody successional species did not differ between tamarisk and cottonwood stands. However, stem densities for this group increased with stand age only for cottonwood, raising the possibility that tamarisk may disrupt successional pathways (Stromberg 1998).

Massive accumulations of duff found under tamarisk canopies (up to 1.5 m) prevented seeds of other species (including tamarisk) from reaching the soil surface. It was also observed that both in field and laboratory studies soils beneath tamarisk canopies were strongly hydrophobic. By water-proofing the soil with the resins and/or sugars of foliage, tamarisk reduces the survival of seedlings (including its own) beneath its canopy (Stevens 2001).

Competition was measured between tamarisk and coyote willow (*Salix exigua*) at various stages of growth. Neither species significantly reduced the germination of the other, but at the end of the second year, tamarisk seedlings growing in the presences of coyote willow suffered reduced growth and 15% higher mortality than in controls. In older class (5 year old) plants, coyote willow suppressed salt cedar growth only slightly (Stevens 2001). In the Southwest among the few species that thrive in a tamarisk understory are 3 non-native brome grasses (*Bromus* spp.). A nonnative, honeydew-producing leafhopper found on tamarisk interacts with a fungus to change soil characteristics increasing saline conditions, so that plant recruitment is virtually eliminated under a tamarisk canopy (Simberloff and VanHolle 1999). With the occupation of tamarisk some riparian areas have seen an increase in fire frequency, compared to the infrequent fires of low- to mid-elevation southwestern riparian plant communities dominated by cottonwood, willow and/or mesquite. While cottonwood and willow species can resprout following fire, tamarisk may be better adapted to the post-fire environment than native species, especially on dammed rivers. This creates an advantage for tamarisk over native species (Busch and Smith 1993).
Sources of information: See cited literature.

Question 1.3 Impact on higher trophic levels *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify type of impact or alteration: Tamarisk displaces native vegetation thus reducing the value of critical habitat for wildlife, including some endangered species. Studies also report that tamarisk plays an important ecological role for wildlife.
Rationale: It is debated as to whether tamarisk provides habitat and nest sites for some wildlife (e.g. white-winged dove), however, most authors have concluded that it has little value to most native amphibians, reptiles, birds, and mammals (Chen 2001). Several studies conclude that tamarisk sustains only poor avian and invertebrate herbivore fauna (Cohan et al. 1978, Hunter et al. 1985, Johnson 1986), whereas other studies report tamarisk as playing a valuable ecological role by supporting herbivores and bird life (Beidieman 1971, Stevens 1976b, Brush 1983, Brown et al. 1984, Stevens and Waring 1985, Warren and Schwalbe 1985, Brotherson and Field 1987, Brown 1987). Tamarisk has replaced the function of native tree species such as cottonwood (*Populus fremontii*) and Goodding willow (*Salix gooddingii*), to a point where some ecologists believe that tamarisk removal could have undesirable effects on endangered species such as the Southwest willow flycatcher (*Empidonax traillii extimus)* (D'Antonio 2000). The flycatcher has been documented as utilizing tamarisk for breeding and nesting purposes, even though reproductive success is lower in tamarisk as compared to native trees (Dudley et al. 2000). At sites throughout the Middle Rio Grande Bewick's wrens nested only in native tree species, especially large cottonwoods (*Populus deltoides*). Analysis of data from 70 sites found wren abundance to be highest at sites dominated by cottonwoods, especially at sites having salt cedar (*Tamarix chinensis*) understories. However, at sites dominated by tamarisk, Bewick's wren abundance was low (Taylor 2003). According to Johnson et al. (1999), the decreasing population of federally listed Southwest willow flycatchers coincides with changing vegetation communities in the bosque community. A bosque is a habitat with extremely moist soil, usually arising from mist, rains, or snow melt, with evergreen shrubs, willows, and an absence of trees. Formerly dominated by native cottonwood and willow, the banks of

the Rio Grande are now dominated by Russian olives and tamarisk, both introduced species. The flycatcher prefers the widely spaced branching of the willows where the bird scans for its prey of local insects. The flycatcher also prefers areas of the bosque covered by standing water or saturated soil (Buckley 1995).

A literature review by Stephenson and Calcarone (1999) suggests that in some cases tamarisk invasions have reduced or eliminated water supplies for bighorn sheep, pupfish, and salamanders. Tamarisk may have negative impacts on threatened and endangered species such as Amargosa pupfish, warm springs pupfish, and speckled dace in Ash Meadows National Wildlife Refuge, Nevada; desert tortoise, and Nelson bighorn sheep, in Lake Mead National Recreation Area, Nevada (Chen 2001).

In the Grand Canyon, tamarisk blossomed abundantly in early June, when few other flowers were available for pollinators. Several invertebrates were observed using tamarisk flowers (Thysanoptera, Coleoptera, some Lepidoptera, Diptera, and Hymenoptera). The significance of this resource for invertebrates could be important but has not been investigated. In a comparison of invertebrate herbivore communities associated with coyote willow and tamarisk, Stevens (1985) found that both species supported equivalent numbers of invertebrate herbivores, but coyote willow supported a more evenly distributed herbivore community with nearly 4 times as many species and a much lower standing crop than tamarisk (Stevens 1985).

Sources of information: See cited literature.

Question 1.4 Impact on genetic integrity *Score:* **D** *Doc'n Level:* **Other pub.**

Identify impacts: No known hybridization.

Rationale: There are no native species within the family *Tamaricaceae* in North America. However, introduced species within the genus do hybridize readily with each other.

Sources of information: Kearney and Peebles (1960). Also considered personal communication with J. Gaskin (North America Flora author, *Tamarix*, 2004).

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**

Describe role of disturbance: The construction of dams alter the hydrology and severely impact natural river flows, thus creating a climate for tamarisk invasion. The rate of tamarisk establishment increases with human and natural disturbance regimes, but it can establish independent of any known human or anthropogenic disturbance.

Rationale: The damming of rivers fed by snowmelt has shifted the time of peak discharge below the dams from spring to summer. This alteration creates conditions favorable to tamarisk seedling establishment, as seeds are just ripening in time with high flows, thus assisting establishment (Shafroth et al. 2002). The creation of lakes and reservoirs with large areas of fine sediment, provide the ideal substrate for tamarisk colonization along the margins. Reduced flood frequency downstream of reservoirs and more stabilized base flows in rivers due to reservoir construction have also created favorable conditions for tamarisk invasion (Everitt 1980). The clearing and plowing of floodplains and associated agricultural activity also aided tamarisk colonization during the 1800s. Tamarisk is also reported to rapidly infest riparian areas exposed to heavy grazing (Stromberg 1998). Once established, wind-borne seed dispersal can become established in otherwise undisturbed areas (DiTomaso 1998).

Sources of information: See cited literature.

Question 2.2 Local rate of spread with no management *Score:* **A** *Doc'n Level:* **Obs.**

Describe rate of spread: Infestations are doubling in <10 years.

Rationale: Since its introduction to the United States in the late 1890s tamarisk has established in nearly every lower-elevation streambed from northern Mexico to southern Canada and recent estimates

indicate infestations in the southwestern U.S. exceed 600,000 hectares (Brotherson and Field 1987). This increase represents at least a 4% increase per year. Tamarisk spread was calculated to be about 20 km of river length per year in the Colorado and Green River systems (Di Tomaso 1998). Working Group members inferred that southwestern trends reflect Arizona's populations of tamarisk.
Sources of information: See cited literature. Score based on inference.

Question 2.3 Recent trend in total area infested within state *Score:* **B** *Doc'n Level:* **Other pub.**
Describe trend: Increasing, but less rapidly than doubling area infested in <10 years.
Rationale: Because much of the riparian habitat in the western U.S. has been invaded by tamarisk, the rate of increase particularly in Arizona has slowed down. However, much of the Salt River through the Tempe and Phoenix area is characterized by scattered individuals of salt cedar, as well as along the Verde River. Salt cedar also occurs along the shore of the San Carlos reservoir and the San Pedro River in southern Arizona Salt cedar also co-dominates with camelthorn (*Alhagi maurorum*) at several sites at Wupatki National Monument in north-central Arizona (Zouhar 2003). The range of tamarisk is continuing to extend northward to Montana and Canada, and southward into northwestern Mexico (DeLoach 1989).
Sources of information: See cited literature.

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe key reproductive characteristics: Tamarisk reproduce vegetatively and prolifically by seed. A single tamarisk tree produces a half million seeds a year.
Rationale: Tamarisk saplings mature rapidly, and some can flower after the first year of growth, but most individuals begin to reproduce in their third year. An Arizona study demonstrated that dense tamarisk stands can generate 100 seeds per square inch (Warren and Turner 1975). Seeds remain viable for several weeks and will germinate on saturated soils or while afloat. It can vegetatively resprout after fire, severe flood, or treatment with herbicides and it is able to accommodate wide variations in soil and mineral gradients in its environment (DiTomaso 1998). Tamarisk is largely insect-pollinated and wind pollination does not occur at a large extent (Stevens 2001).
Sources of information: See cited literature.

Question 2.5 Potential for human-caused dispersal *Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Identify dispersal mechanisms: Anthropogenic factors that facilitate the spread of tamarisk include: intentional tamarisk plantings designed to protect stream banks, control erosion and act as wind breaks; conversion of native riparian forests to agricultural uses. Tamarisk is planted as an ornamental and shade tree and is still widely planted in Mexico. Today the largest human-caused dispersal of tamarisk is facilitated by dam management.
Rationale: Although wind dispersal and ornamental plantings cannot be ruled out as primary transport mechanisms, research on tamarisk dispersal from the Bighorn /Yellowstone River system suggest that boats and machinery transported propagules. Pearce and Smith (2003) studied concentrations and ages of saltcedar at the Musselshell River and Fort Peck Reservoir in Northern Montana to identify concentrations of plants that could be used to infer introduction location, establishment year, and mechanisms of dispersal. Their research suggests that seeds and other plant propagules were also transported to the reservoir by earth-moving equipment during site construction between 1966 and the mid-1980s and later by boats and their towing vehicles. Stromberg (1998) found that conditions that favor cottonwood establishment (frequent winter flooding, high rates of stream flow during spring, exclusion of livestock, employed on the San Pedro River may have led to a decline of tamarisk. This demonstrates that tamarisk dispersal could be lessened by managing rivers toward a natural cycle in which conditions are favorable to cottonwood and willow establishment (Stromberg 1998).

Sources of information: See cited literature.

Question 2.6 Potential for natural long-distance dispersal *Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Lightweight seeds can travel long distances in the wind. Flooding events can move stem and root fragments more than 1 km.
Rationale: Tamarisk seeds are tiny with long hairs that facilitate distribution via the wind, and are carried and deposited along sandbars and riverbanks by water. Stevens (2001) found that tamarisk germination was completed in less than one day after absorption of fluid and subsequent swelling. Stem and root fragments can also float downstream after fragmentation due to flooding events and establish in new areas.
Sources of information: See cited literature; also see DiTomaso (1998) and Lovich (2000).

Question 2.7 Other regions invaded *Score:* **B** *Doc'n Level:* **Other pub.**
Identify other regions: The genus *Tamarix* occurs naturally from western Europe and the Mediterranean to North Africa, northeastern China, India, and Japan. Since its escape from cultivation, salt cedar has spread primarily in the southwestern U.S., Texas and Mexico, although its distribution extends to many other parts of North America. It is especially pervasive in Arizona, New Mexico, western Texas, Nevada, and Utah but is also widespread in southern California, the Rocky Mountain states, the western Plains states, and parts of Oregon, Montana and Idaho. It occurs throughout broad regions of northwestern Mexico and is spreading along the Gulf of Mexico into the coastal prairie (Westbrooks 1998). Tamarisk is a problem in Ash Meadows Wildlife Refuge in Nevada, a montane wetland ecological type.
Rationale: Invades elsewhere but mostly in riparian ecological types that have already been invaded in Arizona. Montane wetlands are an exception. Further investigation should be made into whether tamarisk occurs in montane wetlands and playas in Arizona.
Sources of information: See cited literature; also see Zouhar (2003).

Question 3.1 Ecological amplitude *Score:* **A** *Doc'n Level:* **Other pub.**
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: Tamarisk was not identified in the western U.S. until the 1800s when it was introduced for sale as an ornamental shrub and a windbreak species. It was available in New York City in 1823, in Philadelphia in 1828, and in several nurseries along the eastern seaboard during the 1930s. Tamarisk was listed for sale by nurseries in California as early as 1856. First Arizona record for Tamarisk was from 1916 in Cochise County.
Rationale: Tamarisk is found in riparian communities dominated by green ash (*Fraxinus pennsylvanica*), Arizona sycamore (*Platanus wrightii*), Fremont cottonwood, and Goodding willow (*Salix gooddingii*) in Arizona (and New Mexico).
Sources of information: See Zouhar (2003). Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed February 10, 2004).

Question 3.2 Distribution *Score:* **A** *Doc'n Level:* **Obs.**
Describe distribution: In the southwestern United States, tamarisk occurs in every major watershed, in a variety of community types, many of them dominated by cottonwood (*Populus* spp.) and willow (*Salix* spp.).
Rationale: In Arizona tamarisk is abundant along streams in most of the state below 5,000 feet (1,525 m) and, though it grows in the Southwest at elevation up to 11,000 feet (3350 m), it does not spread rapidly above 4,000 feet (1220 m) (Kartesz and Meacham1999).

Sources of information: See cited literature; also see Zouhar (2003). Also considered information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed February 10, 2004) and Southwest Exotic Plant Mapping Program (SWEMP)-Cain Crisis map (available online at: http://cain.nbii.gov/cgibin/mapserv?map=../html/cain/crisis/crisismaps/crisis.map&mode=browse&layer=state&layer=county; accessed on February 10, 2004).

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	**Yes** $\boxed{\textbf{No}}$ **1 pt.**
Dense infestations produce >1,000 viable seed per square meter	$\boxed{\textbf{Yes}}$ **No** **2 pt.**
Populations of this species produce seeds every year.	$\boxed{\textbf{Yes}}$ **No** **1 pt.**
Seed production sustained for 3 or more months within a population annually	$\boxed{\textbf{Yes}}$ **No** **1 pt.**
Seeds remain viable in soil for three or more years	**Yes** $\boxed{\textbf{No}}$ **2 pt.**
Viable seed produced with *both* self-pollination and cross-pollination	**Yes** $\boxed{\textbf{No}}$ **1 pt.**
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	**Yes** $\boxed{\textbf{No}}$ **1 pt.**
Fragments easily and fragments can become established elsewhere	$\boxed{\textbf{Yes}}$ **No** **2 pt.**
Resprouts readily when cut, grazed, or burned	$\boxed{\textbf{Yes}}$ **No** **1 pt.**
	Total pts: 7 Total unknowns: 0
	Score : A

Note any related traits:

Worksheet B. Arizona Ecological Types
(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	semi-desert grassland	
Freshwater Systems	lakes, ponds, reservoirs	
	rivers, streams	
Non-Riparian Wetlands	Sonoran wetlands	**C**
	southwestern interior wetlands	**D**
	montane wetlands	
	playas	
Riparian	Sonoran riparian	**A**
	southwestern interior riparian	**B**
	montane riparian	**D**
Woodlands	Great Basin conifer woodland	
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	
Tundra (alpine)	tundra (alpine)	

*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

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